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(54) Title: METERING DEVICE FOR A NOZZLE OF AN INJECTION MOLDING APPARATUS

(57) Abstract: An injection molding apparatus includes an injection piston (50) that is slidable within a nozzle (18) having a movable valve gate pin (28). The injection piston (50) is movable from a retracted position to an extended position in order to force melt towards a mold cavity (26). A valve (52) is located at a forward end of the piston (50) to selectively block communication between a recess (48), which is provided in an outer wall (51) of the piston (50) adjacent the valve (52), and a melt chamber (54) of the nozzle (18). Movement of the injection piston (50) from the retracted position to the extended position causes the valve (52) to close so that the predetermined volume of melt located below the valve (52) is forced into the mold cavity (26), when the valve gate pin (28) opens the mold gate (24).

METERING DEVICE FOR A NOZZLE OF AN INJECTION MOLDING APPARATUS

Field Of The Invention

[0001] The present invention relates generally to an injection molding apparatus, and in particular to a metering device for a not runner nozzle, which injects a predetermined quantity of melt into a mold cavity.

Background Of The Invention

[0002] In an injection molding apparatus, a manifold receives a pressurized melt stream from a machine nozzle. The manifold distributes the melt stream to a plurality of nozzles and the melt is forced through the nozzles and into a plurality of mold cavities. The melt is then cooled in the mold cavities and the molded parts are released so that another cycle can begin.

[0003] The amount of melt transferred to each nozzle can vary due to effects such as shear induced flow imbalance in the manifold, for example. In order to compensate for such effects and ensure that a sufficient amount of melt is delivered to each mold cavity, the pressure applied to the melt stream by the machine nozzle must be very high. For applications such as injection molding of thin walled vessels and micro-molding, even higher nozzle pressures are required in order to produce quality molded products. As a result, the machine nozzle must be very large in order to generate sufficient pressure to properly distribute the melt to the mold cavities. In many cases, however, increasing the size of the machine nozzle is not a practical solution. Alternative solutions for increasing the pressure generated in each individual nozzle are therefore desirable.

[0004] Precise measurement of the volume of melt transferred in each shot for thin walled molded parts and micro-molded parts is also very important. This presents a unique challenge particularly when dealing with micro molded parts, which typically weigh a fraction of a gram. Several prior art devices have been developed to control the volume of melt that is injected into a mold cavity. These devices have typically been employed when injecting more than one material into a single mold cavity and tend to be complex and costly to manufacture.

[0005] U.S. Patent No. 5,112,212 to Akselrud et al. discloses a shooting pot, which is used as a metering device, for use in a co-injection molding apparatus. The shooting pot is located remote from the hot runner nozzle and is used to control the volume of one of the two molten materials injected into the cavity. The shooting pot includes a piston that is axially movable within a cylinder to force molten material from the cylinder into a nozzle, which leads to a mold cavity. The cylinder includes an inlet that delivers melt from a melt source to a reservoir, which is located in a lower end of the piston. The piston is rotatable to move the reservoir out of communication with the inlet to seal it off so that when the piston is lowered, a known volume of melt is forced into the mold cavity.

[0006] U.S. Patent No. 4,863,369 to Schad et al. discloses an injection molding apparatus that uses a shooting pot to deliver a precisely measured quantity of melt to a mold cavity. A valve is located in a conduit between a melt source and each nozzle. Once the shooting pot and nozzle are filled with melt, the valve is closed and the mold gate is opened. A piston of the shooting pot advances until it bottoms out in a cylinder to deliver a precise quantity of melt to a mold cavity.

[0007] A disadvantage of shooting pots that are remotely located from the nozzle and the mold cavity is that the known or measured volume of melt may vary from one molding cycle to the next. This occurs because there is a large volume of melt that is located between the shooting pot and the mold cavity ie. the melt in the nozzle, the melt in the manifold channel and the melt in the shooting pot. This large volume of melt introduces several variables. Minor deviations in temperature or pressure, for example, may result in significant variations of the known volume. The sizable distance between the shooting pot and the mold cavity further causes the melt to have a long residence time outside of the nozzle between the injection of one article to the next. This results in molded parts that are not of the highest quality because the temperature of the melt coming from the shooting pot may be either under heated or over heated.

[0008] It is therefore an object of the present invention to provide a metering device for a nozzle of an injection molding apparatus, which obviates or mitigates at least one of the above disadvantages.

Summary Of The Invention

[0009] According to one aspect of the present invention there is provided an injection molding apparatus comprising:

a manifold having a manifold channel for receiving a melt stream of moldable material under pressure, the manifold channel having an outlet for delivering the melt stream to a nozzle channel of a nozzle;

a mold cavity receiving the melt stream from the nozzle, the nozzle channel communicating with the mold cavity through a mold gate;

a gating mechanism for selectively closing the mold gate;

a piston extending through the nozzle channel of the nozzle and being slidable therethrough, an outer wall of the piston abutting an inner wall of the nozzle channel, the piston being movable from a retracted position to an extended position to force melt towards the mold cavity;

a valve located at a forward end of the piston, the valve being selectively movable to block communication between a recess, which is provided in the outer wall of the piston adjacent the valve, and a melt chamber of the nozzle channel, the valve being open to allow melt to flow from the manifold channel into the recess and into the melt chamber of the nozzle channel when the piston is in the retracted position;

wherein movement of the piston towards the extended position forces melt located in the melt chamber of the nozzle channel to flow into the mold cavity.

[0010] According to another aspect of the present invention there is provided a method for forcing melt into a mold cavity of an injection molding apparatus, the method comprising:

closing a mold gate of the mold cavity to block a melt stream from flowing from a nozzle channel of a nozzle into the mold cavity;

maintaining a piston located in the nozzle channel in a retracted position, in which a valve located at a forward end of the piston is open to enable the melt stream to flow from a manifold channel of a manifold, through a recess provided

adjacent the forward end of the piston into a melt chamber of the nozzle channel, to fill the nozzle channel with melt;

closing the valve to block flow of the melt stream between the recess and the melt chamber of the nozzle channel;

opening the mold gate; and

moving the piston towards an extended position to force the melt located in the melt chamber of the nozzle channel into the mold cavity.

[0011] According to another aspect of the present invention there is provided a piston for a nozzle of an injection molding apparatus comprises:

a valve located on a forward end of the piston, the valve being selectively closable to block communication between a recess, which is provided in the outer wall of the piston adjacent the valve, and a melt chamber of a nozzle channel; and

wherein the valve is open to allow melt to flow from the recess past the valve when the piston is in a retracted position and the valve is closed when the piston is moved toward an extended position in order to force melt into a mold cavity.

[0012] According to yet another aspect of the present invention there is provided an injection molding apparatus comprising:

a manifold having a manifold channel for receiving a melt stream of moldable material under pressure, the manifold channel having an outlet for delivering the melt stream to a nozzle channel of a nozzle;

a mold cavity receiving the melt stream from the nozzle channel, the nozzle channel communicating with the mold cavity through a mold gate;

a gating mechanism for selectively closing the mold gate;

a melt chamber located in the nozzle channel adjacent the mold gate, the melt chamber having a predetermined volume;

a valve located between the outlet of the manifold channel and the melt chamber, the valve being selectively movable to control melt flow from the manifold channel into the melt chamber; and

wherein the predetermined volume of melt is injected into the mold cavity in a single shot.

[0013] According to still another embodiment of the present invention there is provided a method of injecting a predetermined volume of a molten material into a mold cavity comprising:

a) injecting molten material through a hot runner manifold into a valve gated hot runner nozzle including a movable valve pin, where the valve pin is in the closed position engaging a mold gate;
b) opening the mold gate;
c) injecting the molten material into a mold cavity through the mold gate by moving an injection piston located at least partially in the nozzle to transfer the predetermined volume of molten material from the hot runner nozzle into the mold cavity.
d) closing the communication between the hot runner nozzle and the mold cavity by moving the valve pin into engagement with the mold gate.

[0014] According to another embodiment of the present invention there is provided a method of injecting a predetermined volume of a molten material into a mold cavity comprising:

a) injecting molten material through a hot runner manifold into a valve gated hot runner nozzle including a movable valve pin, where the valve pin is in the closed position engaging a mold gate;
b) blocking communication between the hot runner manifold and the hot runner nozzle;
c) opening the mold gate;
d) moving an injection piston located at least partially in the nozzle toward the mold gate to transfer the predetermined volume of molten material from the hot runner nozzle into the mold cavity;
e) closing the communication between the nozzle and the mold cavity by moving the valve pin into engagement with the mold gate.

[0015] The present invention provides an advantage in that a metered quantity of melt is delivered consistently to a mold cavity.

Brief Description Of The Drawings

[0016] Embodiments of the present invention will now be described more fully with reference to the accompanying drawings in which:

Figure 1 is a side sectional view of an injection molding apparatus of the present invention;

Figure 2 is a side sectional view of a valve of a piston of Figure 1;

Figure 3 is a view on 3-3 of Figure 2;

Figure 4 is a view on 4-4 of Figure 3;

Figures 5 to 9 are schematic side views of a portion of Figure 1 at different stages of the injection cycle;

Figure 10 is a schematic side sectional view of another embodiment of an injection molding apparatus of the present invention.

Detailed Description Of The Preferred Embodiment

[0017] Referring to Figure 1, portions of an injection molding apparatus are generally shown at 10. The injection molding apparatus 10 comprises a manifold 12 having a manifold melt channel 14 for receiving a melt stream of moldable material under pressure from a manifold bushing 16. The manifold bushing 16 is in communication with a machine nozzle (not shown). Bores 20 extend through the manifold 12 at distal ends of the manifold melt channel 14. The bores 20 are in communication with the melt channel 14 and extend generally perpendicular thereto.

[0018] Hot runner nozzles 18 are coupled to a lower surface of the manifold 12. A nozzle channel 22 of each nozzle 18 is aligned with a respective bore 20 to receive the melt stream of moldable material from the manifold 12. A mold gate 24 is located adjacent the tip of each nozzle 18. The mold gates 24 are openable to allow delivery of the melt stream to respective mold cavities 26. Any number of nozzles 18 can be used to feed either a single or a plurality of mold cavities 26. The mold cavities 26 may be of the same size and shape or they may differ. Manifold heaters (not shown) and nozzle heaters 32 maintain the melt stream at a desired temperature and cooling channels (not shown) facilitate cooling of the mold cavities 26.

[0019] A metering device in the form of a hot runner injection piston 40 is slidable through the bore 20 of the manifold 12 and the nozzle 18. A valve pin 28 extends through a central bore 42 of the injection piston 40 and is slidable therethrough to open and close the mold gate 24. The injection piston 40 and the valve pin 28 are driven independently and move relative to one another. The valve pin 28 is pneumatically driven by a valve piston 30 that is slidable in a cylinder 34. The injection piston 40 is pneumatically driven by a second piston 44 that is slidable in a second cylinder 46. The injection piston 40 and valve pin 28 are not limited to being driven pneumatically, they may be also driven hydraulically or by any other suitable means, including electrical and electromagnetic motors. In addition, the valve pin 28 may be replaced by another type of gating mechanism.

[0020] The injection piston 40 further comprises a piston body 50 that extends outwardly from the second piston 44. The piston body 50 is coupled to the second piston 44 by fasteners (not shown). Alternatively, the piston body 50 may be integral with the piston 44. The piston body 50 includes an outer surface 51, which blocks the communication between the manifold channel 14 and the nozzle channel 22 during movement of the piston body 50 towards the mold cavity 26. An annular recess 48 is provided in the outer surface 51 of the piston body 50. It will be appreciated that the annular recess 48 need not extend around the entire circumference of the outer surface 51. A valve, generally indicated at 52, is located at a forward end of the piston body 50 adjacent the recess 48. The valve 52 is openable to enable communication between the recess 48 and a melt chamber 54 of the nozzle channel 22. The melt chamber 54 of the nozzle channel 22 is located between the mold gate 24 and the valve 52. When the injection piston 40 is in the retracted position and the valve pin 28 is in the closed position, the volume of the melt in the melt chamber 54 of the nozzle 18 is known. The known volume of melt in the melt chamber 54 corresponds to the volume of melt to be injected into each mold cavity 26. The close proximity of the known volume of melt to be injected and the mold cavity 26 reduces the amount of variability experienced by prior art devices.

[0021] Referring to Figures 2-4, the valve 52 is better illustrated. The valve comprises a flange 56 that extends outwardly from a lower end of the piston body 50.

As shown in Figure 3, the flange 56 includes a series of cutouts 58 that are spaced around the circumference thereof. A disc 66 is axially movable relative to the flange 56. The disc 66 includes a second series of cutouts 72 that are spaced around the circumference thereof. The disc 66 is oriented so that the second series of cutouts 72 is angularly offset from the series of cutouts 58 of the flange 56. The disc 66 and the flange 56 having the same outer diameter. This arrangement ensures that when the disc 66 abuts the flange 56, no melt can flow past the valve 52 in either direction so that the desired amount of melt, which is located in the melt chamber 54, is injected into the mold cavity 26.

[0022] The disc 66 further includes a stem 68 that extends outwardly therefrom and an enlarged head 70 that is mounted on the end of the stem 68. A central cavity 60 is provided in the lower end of the piston body 50 to receive the enlarged head 70 and limit the distance of travel thereof. The enlarged head 70 abuts a shoulder 62 of the central cavity 60 when the valve 52 is in the fully open position. The stem 68 is axially movable through a square-shaped bore 64 to reciprocate the disc 66 into and out of engagement with the flange 56. The square shape is used to prevent rotation of the disc 66 with respect to the flange 56. It will be appreciated that the stem 68 may be any shape or configuration that prevents rotation of the disc 66, for example, the stem 68 may be circular with a groove for receiving a dowel. The disc 66 is movable together with and independent of the piston body 50 as a result of the force exerted thereon by the melt in the nozzle channel. Retraction of the injection piston 40 causes the valve 52 to open by creating a gap 80 between the flange 56 and the disc 66, and extension of the injection piston 40 causes the valve 52 to close by eliminating the gap 80. Other arrangements may be used to provide a valve that performs the same function.

[0023] In operation, the pressurized melt stream flows through the manifold bushing 16 to the manifold channel 14 of the manifold 12. Referring to Figure 5, the cycle begins with the mold gate 24 in the closed position, in which the valve pin 28 engages the mold gate 24, and the injection piston 40 in the retracted position. In the retracted position, the recess 48 is aligned with the manifold channel 14 to receive melt therefrom. The melt flows from the manifold 12 into the recess 48, which forces

the valve 52 into the fully open position to allow melt to fill the nozzle channel 22. Once the nozzle 18 is full of melt, the injection piston 40 is moved toward the extended position as indicated by arrow 82 in Figure 6. The forward movement of the injection piston 40 causes the disc 66 to be forced toward the flange 56 to close the valve 52. At the same time, the outer surface 51 of the piston body 50 shuts off communication between the manifold channel 14 and the nozzle channel 22. In this position, no additional melt can enter the melt chamber 54. Referring to Figure 7, once the melt chamber 54 has been isolated from the rest of the nozzle channel 22, the mold gate 24 is opened by retracting the valve pin 28, as indicated by arrow 84. The forward stroke of the injection piston 40, indicated by arrow 86, then forces the melt located in the melt chamber 54 of the nozzle channel 22 into the mold cavity 26, as shown in Figure 8. The mold gate 24 is then closed by extending the valve pin 28, as indicated by arrow 88 in Figure 9, and the injection piston 40 returns to the retracted position, as indicated by arrow 90. This returns the injection piston 40 and valve pin 28 to the positions of Figure 5 so that the cycle can be repeated. As will be appreciated, this arrangement ensures that the volume of melt injected into the mold cavity 26 is equal for each mold cavity 26 and is constant for every cycle.

[0024] Referring to Figure 10, another embodiment of an injection molding apparatus 110 is shown. The numerals used previously in describing Figure 1 will be used again after raising the numerals by 100 where the parts to be described correspond to parts already described. The injection molding apparatus 110 is similar to the injection molding apparatus of Figure 1 with the addition of pressure sensors 200, 202 and 204, which are provided in the mold cavity 126, the nozzle channel 122 and the manifold channel 114, respectively. The pressure sensors 200, 202 and 204 send information to the hot runner and mold controller 206 for use in controlling the timing and sequence of movements of the injection piston 140 and the valve pin 128. It will be appreciated that it is not necessary to use all three pressure sensors 200, 202, 204. If desired, only one or two of the pressure sensors 200, 202, 204 may be used.

[0025] Temperature sensors 208 and 210 are provided to measure the temperature of melt in the mold cavity 126 and in the nozzle 118, respectively. An additional sensor (not shown) may be provided in the manifold 112. Like the pressure

sensors 200, 202, 204, the temperature sensors 208, 210 also send information to the controller 206 for use in controlling the timing and sequence of movements of the injection piston 140 and the valve pin 128. The controller 206 communicates with a motion drive 216 which, in turn, communicates with position sensors 212 and 214. The position sensors 212, 214 are used to control the position and movement of the injection piston 140 and the valve pin 128, respectively. The sensors may be of any known type, such as, for example, optical or inductive sensors. In some cases, only the position sensors 212 and 214 may be used for the purpose of simplifying the injection molding apparatus 110.

[0026] This arrangement is particularly useful in an injection molding apparatus 110 in which all of the cavities have the same size. The sensors 200, 202, 204 may be used to ensure that the pressure is generally equal in each of the mold cavities 126 and is generally equal between different batches of molded parts. The sensors 200, 202, 204 are also useful in the case of a family mold, in which the pressure in each mold cavity 126 is different and corresponds to a predetermined value.

[0027] Because a manifold typically supports more than one nozzle, it will be appreciated by a person skilled in the art that the movement of the individual pistons of each nozzle may be staggered so that the pressure from the machine nozzle can remain constant.

[0028] In a further embodiment, the mold cavities 26 are of different sizes. In order to properly fill each mold cavity 26, the melt chamber 54 of each nozzle 18 must be sized to accommodate the correct volume of melt. The nozzles 18 associated with each mold cavity 26 are identical, however, each injection piston 40 must be sized accordingly.

[0029] Although a preferred embodiment of the present invention has been described, those of skill in the art will appreciate that variations and modifications may be made without departing from the spirit and scope thereof as defined by the appended claims.

We Claim:

1. An injection molding apparatus comprising:

a manifold having a manifold channel for receiving a melt stream of moldable material under pressure, said manifold channel having an outlet for delivering the melt stream to a nozzle channel of a nozzle;

a mold cavity receiving said melt stream from said nozzle, said nozzle channel communicating with said mold cavity through a mold gate;

a gating mechanism for selectively closing said mold gate;

an injection piston extending through said nozzle channel of said nozzle and being slidable therethrough, an outer wall of said injection piston abutting an inner wall of said nozzle channel, said injection piston being movable from a retracted position to an extended position to force melt towards said mold cavity;

a valve located at a forward end of said injection piston, said valve being selectively movable to block communication between a recess, which is provided in said outer wall of said injection piston adjacent said valve, and a melt chamber of said nozzle channel, said valve being open to allow melt to flow from said manifold channel into said recess and into said melt chamber of said nozzle channel when said injection piston is in said retracted position;

wherein movement of said injection piston towards said extended position forces melt located in said melt chamber of said nozzle channel to flow into said mold cavity.

2. An injection molding apparatus as claimed in claim 1, wherein a predetermined volume of melt is located in said melt chamber of said nozzle channel.

3. An injection molding apparatus as claimed in claim 1, wherein said gating mechanism is a valve pin driven by a piston.

4. An injection molding apparatus as claimed in claim 2 wherein movement of said injection piston from said retracted position to said extended position causes said valve to close.

5. An injection molding apparatus as claimed in claim 2, wherein movement of said injection piston from said extended position to said retracted position causes said valve to open.

6. An injection molding apparatus as claimed in claim 2, wherein movement of said injection piston is controlled by a controller that receives information from a pressure sensor that senses the pressure of at least one of said mold cavity, said nozzle channel and said manifold channel.

7. An injection molding apparatus as claimed in claim 6, wherein said controller further receives information from a temperature sensor that senses the temperature of at least one of said mold cavity, said nozzle channel and said manifold channel.

8. A method of forcing melt into a mold cavity of an injection molding apparatus, said method comprising:

closing a mold gate of said mold cavity to block a melt stream from flowing from a nozzle channel of a nozzle into said mold cavity;

maintaining an injection piston located in said nozzle channel in a retracted position, in which a valve located at a forward end of said injection piston is open to enable the melt stream to flow from a manifold channel of a manifold, through a recess provided adjacent said forward end of said injection piston into a melt chamber of said nozzle channel, to fill said nozzle channel with melt;

closing said valve to block flow of the melt stream between said recess and said melt chamber of said nozzle channel;

opening said mold gate; and

moving said injection piston towards an extended position to force the melt located in said melt chamber of said nozzle channel into said mold cavity.

9. An injection piston for a nozzle of an injection molding apparatus comprises:

a valve located on a forward end of said injection piston, said valve being selectively closable to block communication between a recess, which is provided in said outer wall of said injection piston adjacent said valve, and a melt chamber of a nozzle channel; and

wherein said valve is open to allow melt to flow from said recess past said valve when said injection piston is in a retracted position and said valve is closed when said injection piston is moved toward an extended position in order to force melt into a mold cavity.

10. An injection molding apparatus comprising:

a manifold having a manifold channel for receiving a melt stream of moldable material under pressure, said manifold channel having an outlet for delivering the melt stream to a nozzle channel of a nozzle;

a mold cavity receiving the melt stream from said nozzle channel, said nozzle channel communicating with said mold cavity through a mold gate;

a gating mechanism for selectively closing said mold gate;

a melt chamber located in said nozzle channel adjacent said mold gate, said melt chamber having a predetermined volume;

a valve located between said outlet of said manifold channel and said melt chamber, said valve being selectively movable to control melt flow from said manifold channel into said melt chamber; and

wherein said predetermined volume of melt is injected into said mold cavity in a single shot.

11. The injection molding apparatus of claim 10, wherein said valve is located at a forward end of a injection piston, said injection piston being slidable

within said nozzle channel to force melt from said melt chamber into said mold cavity.

12. A method of injecting a predetermined volume of a molten material into a mold cavity comprising:

a) injecting molten material through a hot runner manifold into a valve gated hot runner nozzle including a movable valve pin, where the valve pin is in the closed position engaging a mold gate;

b) opening the mold gate;

c) injecting the molten material into a mold cavity through the mold gate by moving an injection piston located at least partially in the nozzle to transfer the predetermined volume of molten material from the hot runner nozzle into the mold cavity.

d) closing the communication between the hot runner nozzle and the mold cavity by moving the valve pin into engagement with the mold gate.

13. A method as claimed in claim 12, wherein movement of said injection piston is controlled by a controller that receives information from a process sensor

14. A method as claimed in claim 13, wherein said process sensor in one or a combination of a pressure and a temperature sensor.

15. A method as claimed in claim 13, wherein said process sensor is located in at least one of said mold cavity, said nozzle channel and said manifold channel

16. A method of injecting a molten material into a mold cavity comprising:

a) injecting molten material through a hot runner manifold into the melt chamber of a hot runner nozzle including a movable valve pin, where the valve pin is in the closed position engaging a mold gate;

b) blocking communication between the hot runner manifold and the hot runner nozzle;

c) opening the mold gate;

d) moving an injection piston located at least partially in the nozzle toward the mold gate to transfer a predetermined volume of molten material from the melt chamber of the hot runner nozzle into the mold cavity;

e) closing the communication between the nozzle and the mold cavity by moving the valve pin into engagement with the mold gate.

17. A method as claimed in claim 16, wherein movement of said injection piston is controlled by a controller that receives information from a process sensor that senses said information from at least one of said mold cavity, said nozzle channel and said manifold channel.

18. A method as claimed in claim 17, wherein said controller receives information from either a temperature sensor, a pressure sensor, a piston position sensor or any combination of the three.

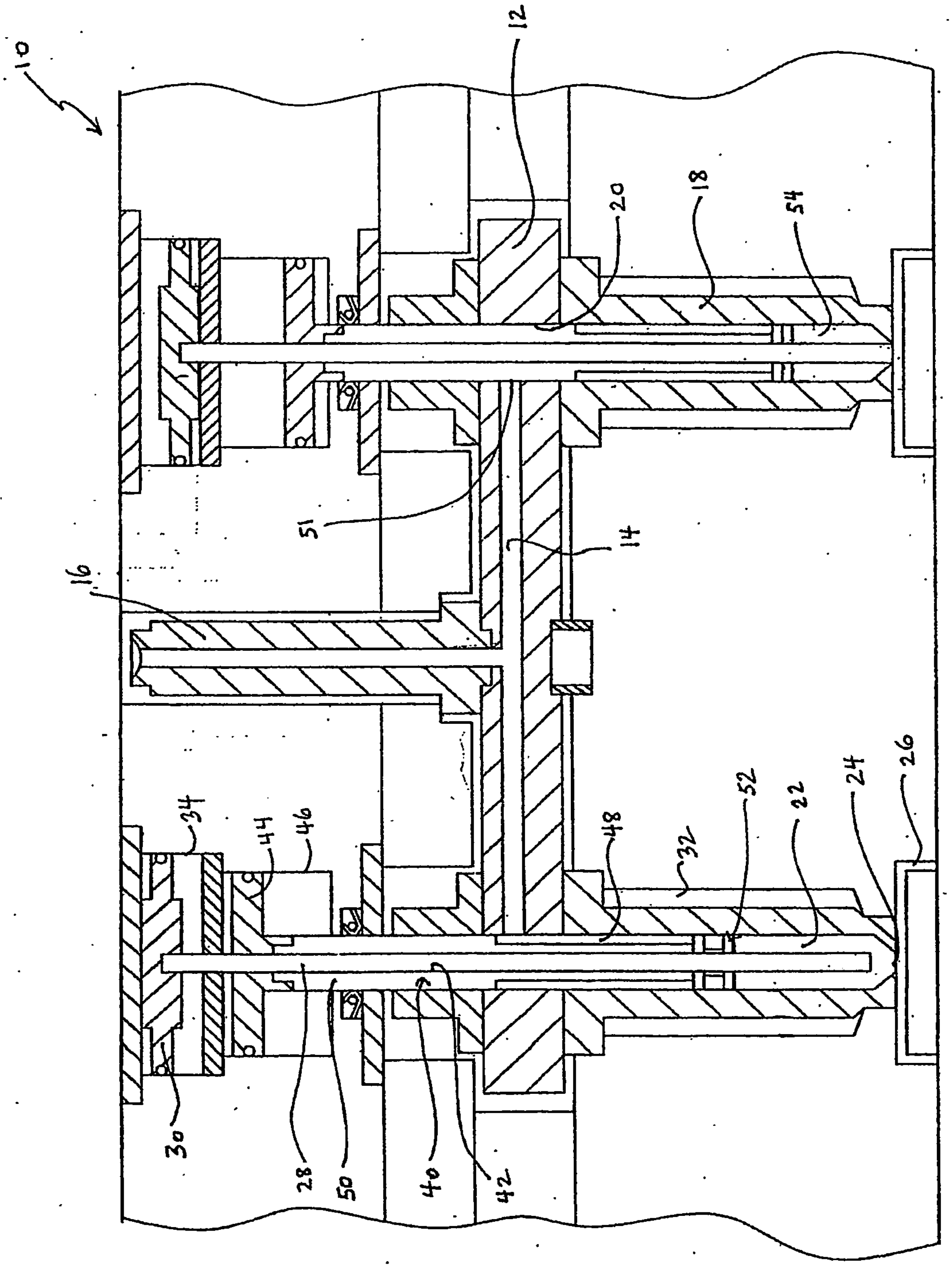

Figure 1

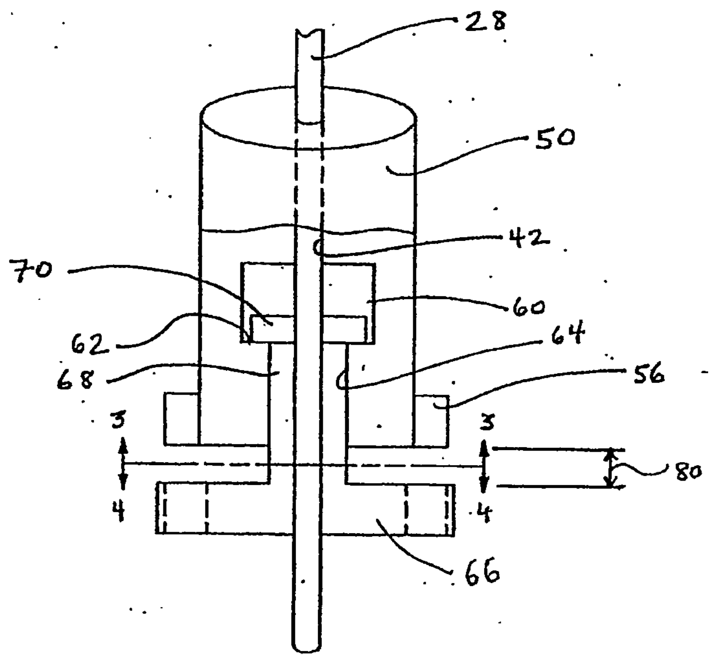

Figure 2

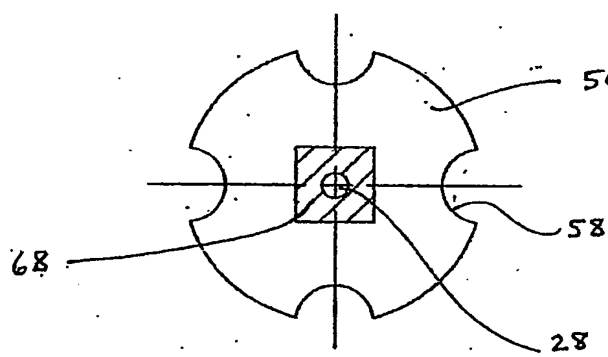

Figure 3

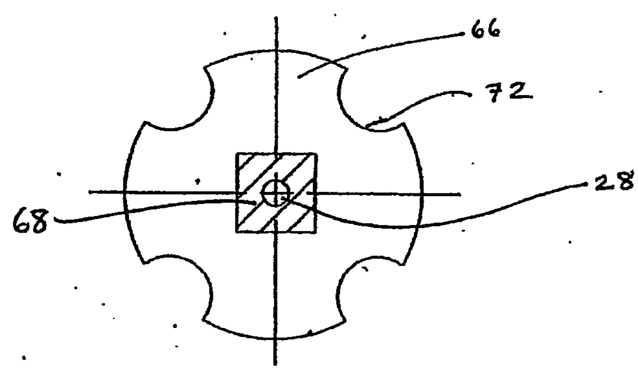

Figure 4

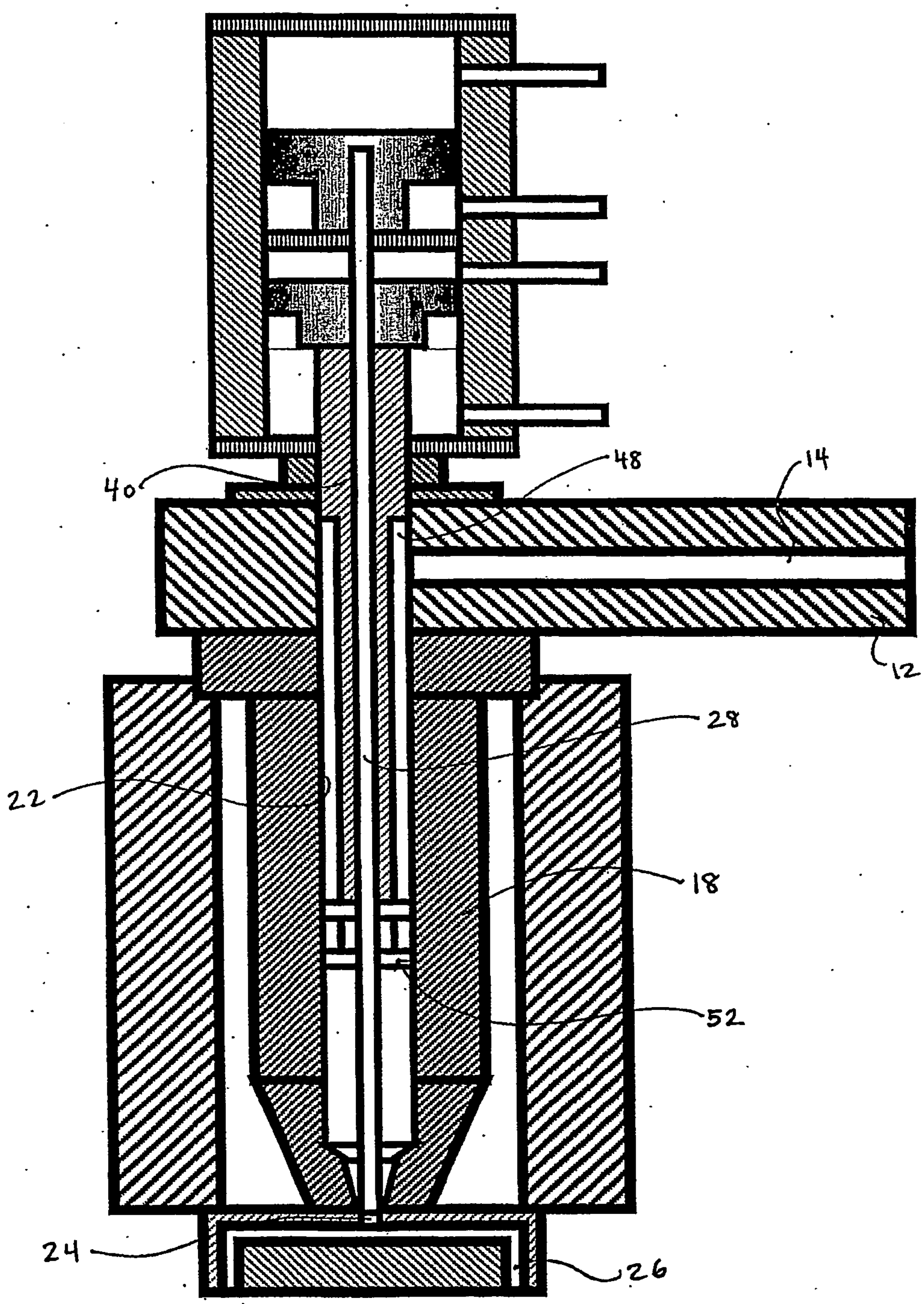

Figure 5

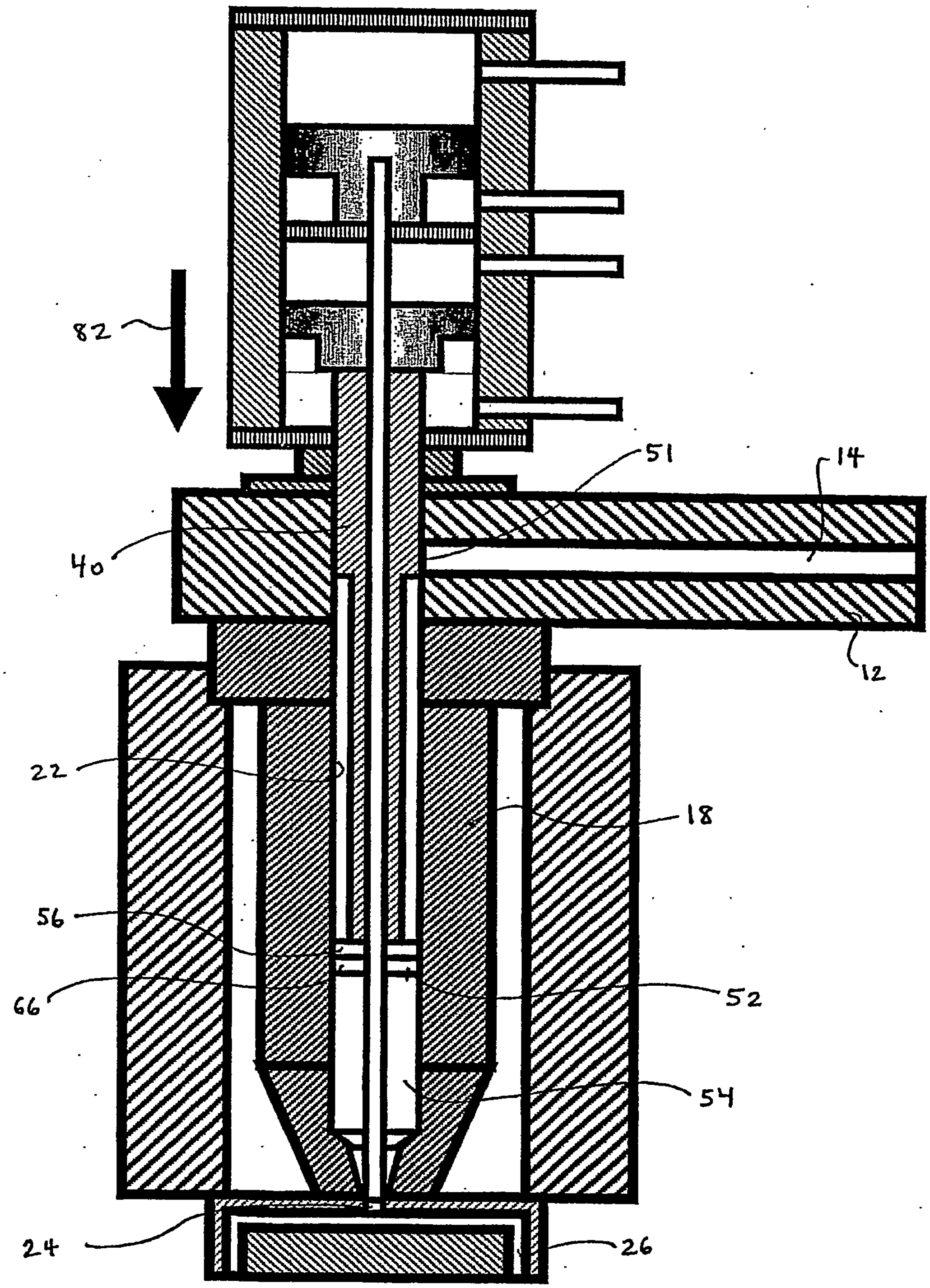

Figure 6

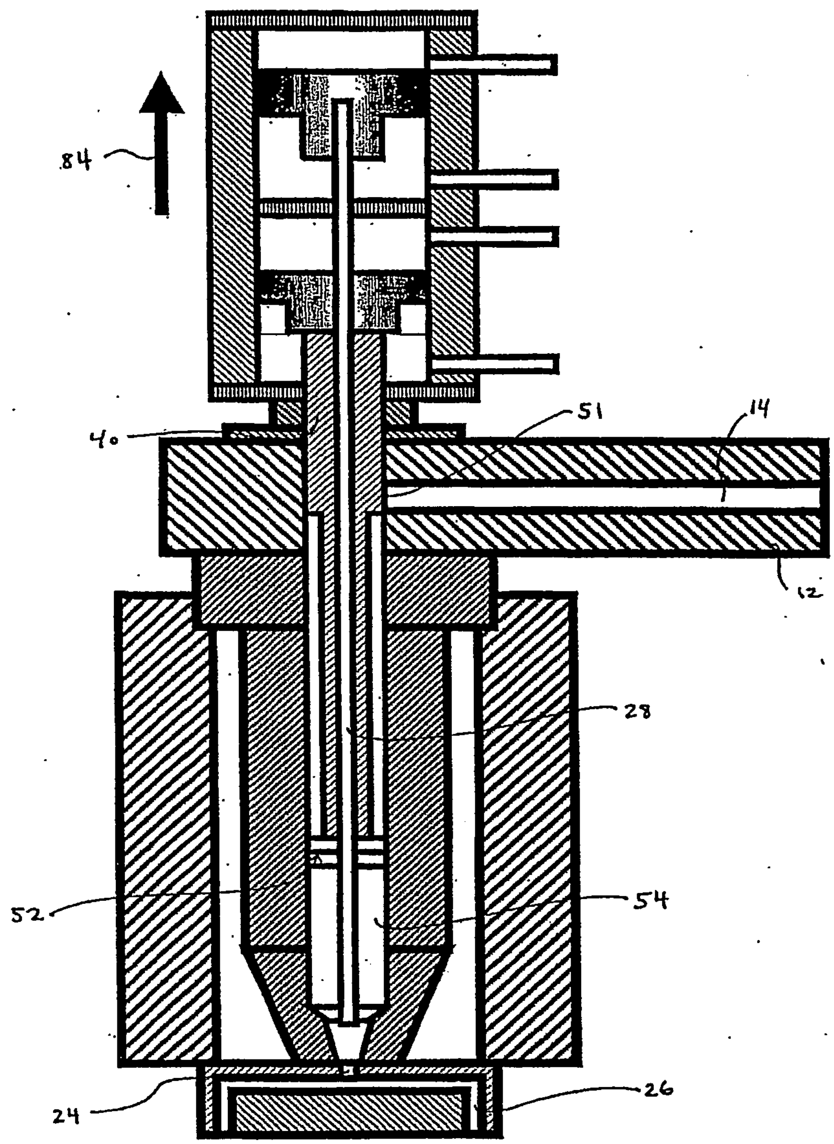

Figure 7

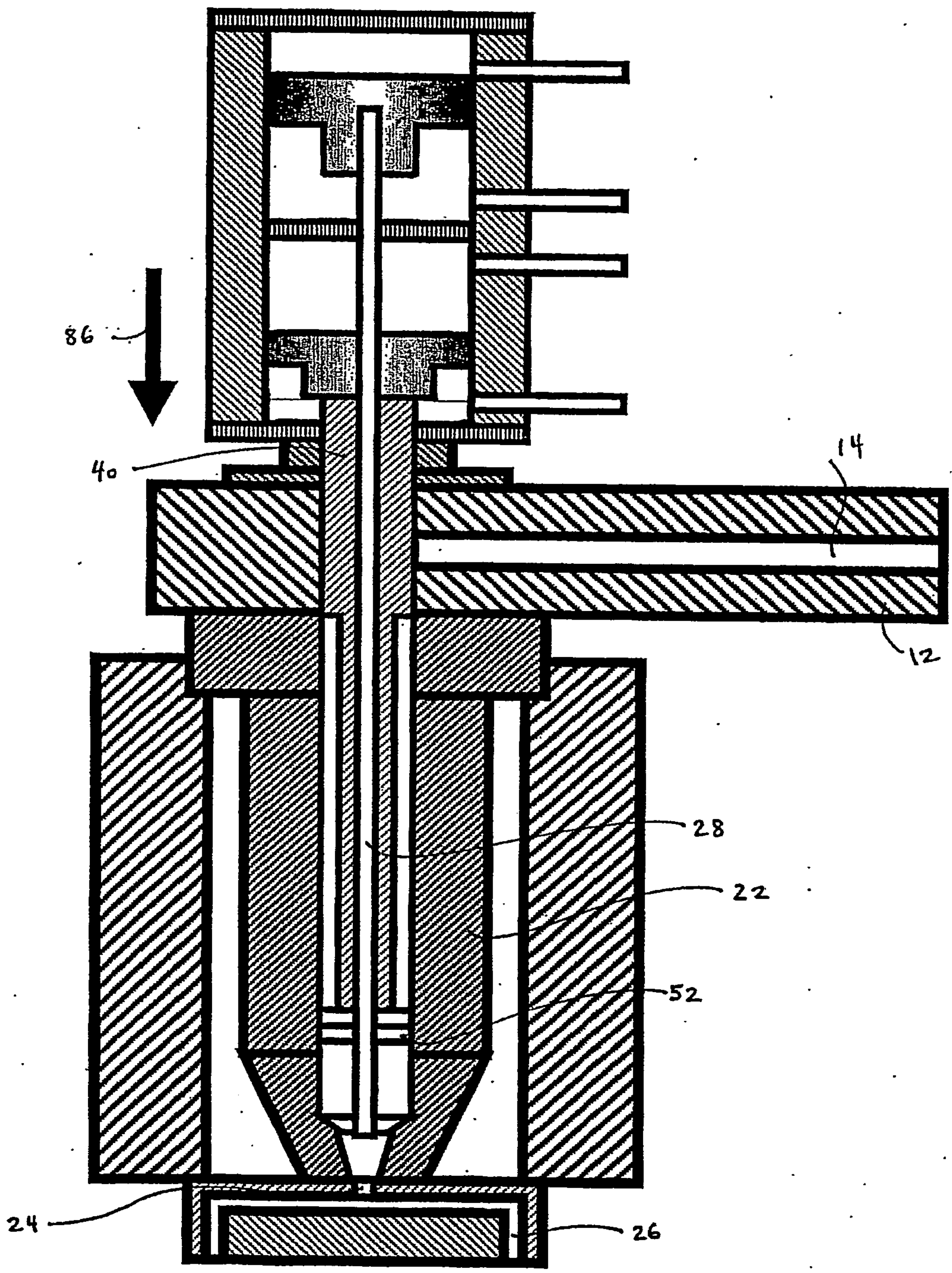

Figure 8

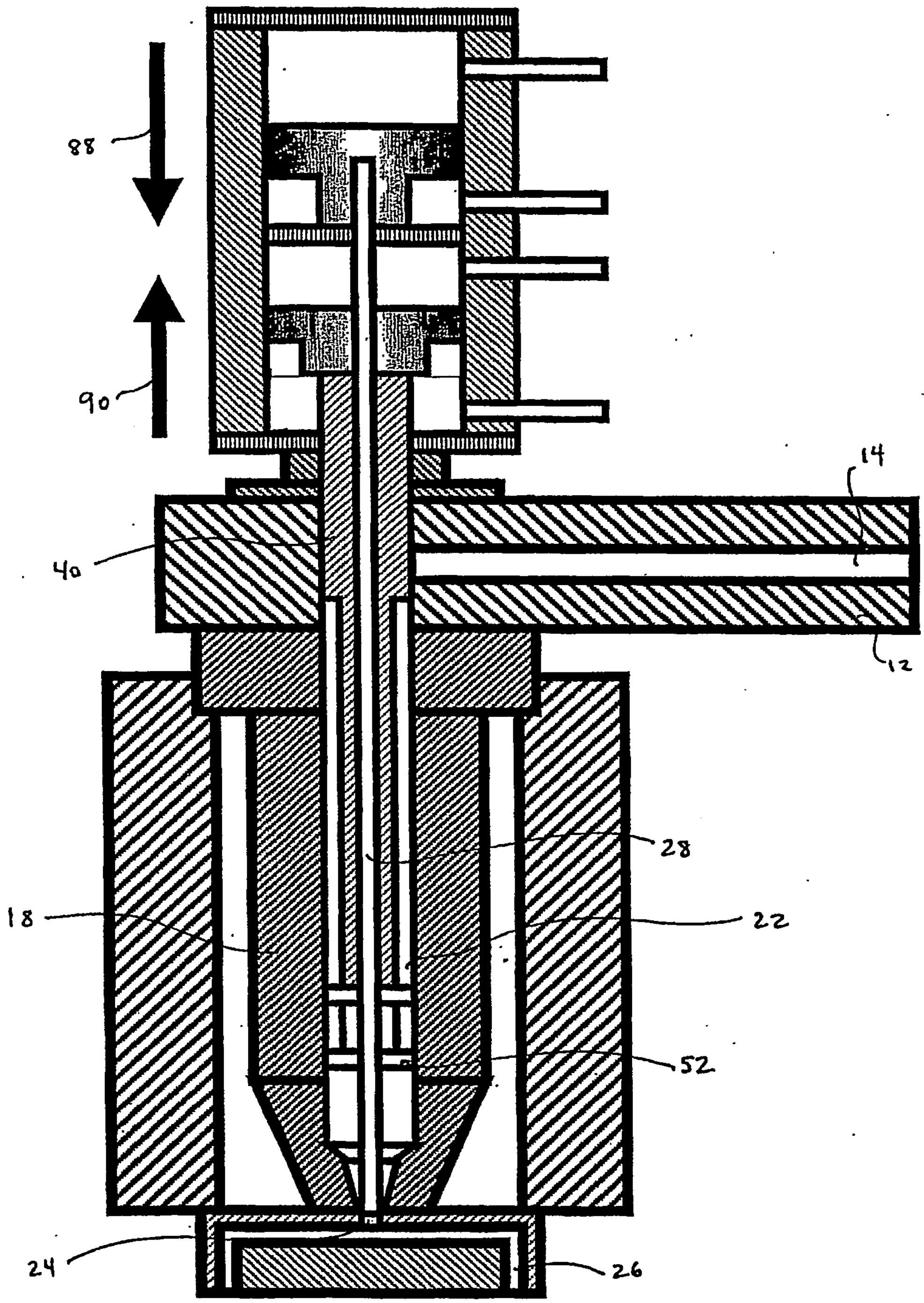

Figure 9

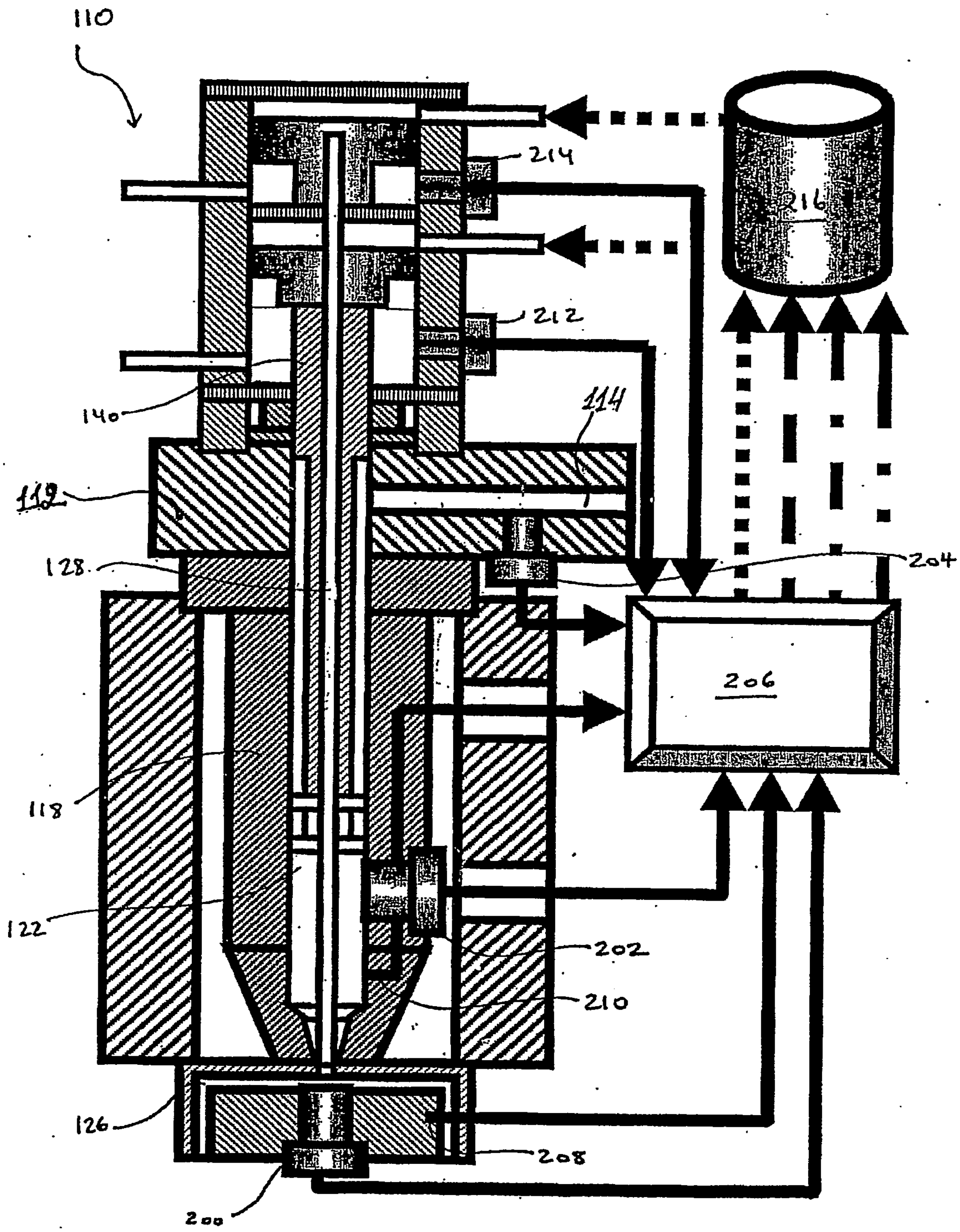
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Figure 10

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 03/01368

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B29C45/02 B29C45/27 B29C45/28 //B29C45/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 05, 30 June 1995 (1995-06-30) -& JP 07 040400 A (MITSUBISHI MATERIALS CORP), 10 February 1995 (1995-02-10)	10,12,16
A	abstract	1-3,8,9
X	US 6 045 740 A (GOERLICH RUDOLF) 4 April 2000 (2000-04-04)	12
A	column 4, line 1 - line 43; figure 2	1,8,10, 16
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 February 2004	12/02/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Zattoni, F

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 03/01368

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 5 260 012 A (ARNOTT ROBIN) 9 November 1993 (1993-11-09) the whole document	1,8,10, 12,16
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